ENVIRONMENTAL RESEARCH CENTER

CENTER FOR ENVIRONMENTAL RESOURCE MANAGEMENT
THE UNIVERSITY OF TEXAS AT EL PASO

Cooperative Agreement: CR-819849-01

1995 Annual Report
January 1 to December 31, 1995

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THE CENTER AT A GLANCE

The mission of the EPA-supported Environmental Research Center at the University of Texas at El Paso (UTEP) is to establish and maintain a coherent program of education, outreach, and research to support analyses and remediation of critical Superfund-related environmental issues. The principal reasearch emphasis has been on the detection, assessment and evaluation of the risks to human health of hazardous substances and the detection and remediation of hazardous substances in the environment.

The Center is integrated into UTEP's existing Center for Environmental Resource Management (CERM). CERM provides university-wide coordination of outreach, service, education, policy, research, development, and technology transfer activities that focus on environmental issues, as well as support for a culturally diverse student population to develop skills necessary to become environmental engineers and scientists. CERM's goal is to address the mounting environmental problems that threaten the health, safety, well-being, and economic development of the southwest border region of the United States and northern Mexico.

Although the Environmental Center's effort has been focused on Superfund-related issues, the problems of the southwest border region are broader in scope. Accordingly, the center seeks to address the broad spectrum of issues that confront the southwest border, to include hazardous waste, air quality, water availability and quality, and ecological, public health, and policy issues.

CERM's goal is to address the mounting environmental problems that threaten the health, safety, well-being, and economic development of the southwest border region of the United States and northern Mexico.

DATA

EPA Funding (to date)	
Date	**Amount**
Mar 93	$500,000
Sep 93	$500,000
Jul 94	$1,000,000
Sep 95	$1,000,000
Total	**$3,000,000**

Allocation of Research Funds		
Thrust:	**Projects**	**Amount**
Bioremediation	3	$313,431
Waste Management	3	$364,075
Risk Identification	1	$102,844
Environmental Justice	1	$154,227
Health Risk Analysis	1	$107,854
Off Campus Research (UTSA-bioremediation)	1	$50,000
Faculty Development and Planning Grants	7	$198,897
Total:	**17**	**$1,291,328**

CENTER DIRECTOR'S REPORT

I take great pleasure in submitting the Director's Report of the activities of the Center for Environmental Resource Management at the University of Texas at El Paso. I believe our cooperative agreement is accomplishing its intended purposes: we are building the capacity of the University to address the environmental problems of the area, and we are developing our students to be environmental scientists and engineers through the conduct of research projects consistent with our mission.

This report addresses a number of topics of major interest. Following the narrative, I have highlighted, in bullet form, the Center's major accomplishments of 1995 and our major goals and priorities for 1996.

Change of Director

In January, 1995, Dr. Stephen Riter, then director, was appointed interim Vice President for Academic Affairs. He relinquished his responsibilities as Dean of the College of Engineering, but remained as Director of the Center pending the selection of a replacement.

Dr. Charles G. (Chip) Groat became the Director on July 15, 1995. He came to UTEP from Louisiana State University, where he was the Director of the Center for Coastal, Energy, and Environmental Resources (CCEER). Dr. Groat is not a stranger to UTEP; from 1976 to 1978 he was the Chairman of the Department of Geological Sciences. In addition to his appointment as Director of CERM, he was appointed as a Professor in the Department of Geological Sciences.

Environmental Research Activity

On-campus research. Calendar year 1995 began with nine research projects underway. Four of these projects were started late in 1993, four in the middle of 1994, and the last began in October 1994. Five of these projects concluded in 1995, and four will end in 1996.

Overall, the nine projects comprise a multi-dimensional thrust into basic environmental and hazardous substance issues. Specific thrust areas are:

- Bioremediation of hazardous waste and

contamination
- Waste management
- Detection of hazardous materials (Risk Identification)
- Environmental justice and policy, and
- Health issues of risk analysis and communication.

Off-campus research. In Spring the Center expanded its program to include another culturally divers university, the University of Texas at San Antonio (UTSA). We met with Dr. Thomas E. Owen, the Director of the Institute for Research in Sciences and Engineering at UTSA. As a result of our conversations, we provided support to a preliminary study by Drs. Neal Guentzel and Barbara Moore, "Biodegradation of Chlorinated Alkenes and Chlorinated Benzenes by Aerobic Microbial Metabolism."

The table at the end of this section lists the titles of all research projects (on campus and off). Individual project reports are found elsewhere.

Faculty Development and Planning Grant Program

The Center awarded seven development and planning grants to nine UTEP faculty members to sponsor preliminary planning activities in the summer of 1995. This program has several purposes:

1. To expand UTEP's environmental capability and infrastructure. (This is also one of the missions of our Environmental Research Center.)

2. To facilitate the involvement of new faculty in UTEP's environmental programs.

3. To strengthen their ability to develop a viable environmental research or outreach program and compete for funding from a variety of sources.

Project titles are listed in the table at the end of this section of the report.

This program has expanded faculty interest in environmental matters. Several proposals have been submitted to various sources by faculty members who competed for the Faculty Development and Planning Grants.

Doctoral Program in Environmental Science and Engineering

Two of the purposes of the Center are to expand the infrastructure of the university to enable it to better address the problems of the region and provide opportunities for our culturally diverse population to train as environmental scientists and engineers. With the Center's help, the university has been able to attract new faculty with environmental science and engineering backgrounds. These new faculty members have, in turn, enabled the university to offer new courses and academic programs. Nevertheless, the area's increasing demand for environmental scientists and engineers pointed to a need for a terminal degree program.

The Texas Higher Education Coordinating Board, at its April 28, 1995 meeting, approved the first reading of the request for UTEP to offer a Ph.D. in Environmental Science and Engineering (ESE). The second reading for the degree program was approved in July 1995 and the program was begun in September 1995.

UTEP's ESE Ph.D. program is an interdisciplinary doctoral program and, as such, is not assigned to one of the academic colleges or departments. It is housed in CERM and administered by Dr. Groat. This unique organizational structure allows the university to ensure the interdisciplinary nature of the program.

Why a Ph.D. program is necessary for UTEP

We believe that the people who will learn to solve the environmental problems of the border region will be the people who live in that region. And the people who live in that region go to UTEP.

The program prepares scientists and engineers to address the environmental issues facing this region, the nation, and the world. It will produce graduates who can apply a cross-disciplinary perspective to the understanding, management, and remediation of human impacts on the environment, with particular focus on the problems of the Southwest Border region.

The program is designed for individuals with environmentally-related master's degrees in engineering or the natural sciences. Doctoral candidates will complete at least 60 credit hours beyond the master's degree, including course work providing in-depth treatment of current technologies for environmental protection and remediation and fundamental concepts in environmental biology, ecology, geology, and chemistry. The core course work also emphasizes environmental policy, law, and ethics, providing graduates with an understanding of the social and political context of environmental issues. The severe environmental problems that face the U.S.-Mexico border region will provide a special focus for course work and research. It will also provide an opportunity for students to work together on interdisciplinary projects designed to develop an understanding of the interrelationship of various disciplines in addressing environmental concerns. Graduates of the program will have the knowledge and skills to serve at the highest levels as practitioners and in academic positions.

At present, there are 16 students in the program.

UTEP'S Proposal for Third Year Funding Award Delay Leads to Temporary Shutdown.

In June 1995, we submitted an application for funding ($1,000,000) for the third year of the cooperative agreement. Our request also asked for authorization to carry over $400,000 in prior year funding.

Unfortunately, the agreement was not renewed by the expiration date of the budget period, August 31, 1995. Consequently, we directed all research projects to suspend operations. This was particularly difficult for the students we supported.

The third-year renewal (amendment 5 to the cooperative agreement) was awarded in late September. By the time the paperwork traveled through EPA headquarters and our University administration, we had been shut down for six weeks. It took another two weeks to restart.

Amendment 5 reflected the increase of the requested $1,000,000. It also modified the budget period by extending

it to the end of the project period, August 31, 1998. This action allows the Center to carryover the $400,000, as requested, and, perhaps more importantly, streamlines the assistant agreement and greatly increases the flexibility of both the Center and the EPA in accomplishing our objectives. It virtually precludes the recurrence of another shutdown pending the next renewal.

Development of the FY96 Environmental Research Program

Upon receipt of the third-year's allocation of funds we began to design our research program for the next year. While we are mindful that there is a necessary emphasis on Superfund issues we felt our efforts should include the full range of environmental issues that are present in the El Paso border region. We recognize that we live in a region that is a virtual laboratory of unique, bi-national, multi-cultural environmental problems. These problems threaten the health, safety, well-being, and the economic development of the region and are having a disproportionate adverse impact on low-income Hispanic residents. Therefore, we feel the expansion of our effort is a necessary step toward the attainment of improved environmental quality and justice.

We also wanted to address issues that call for practical solutions that have potential for immediate application. We want our researchers to identify specific end-users or clients for their research. We want the end-users/clients to be involved in the research by, as a minimum, stating what their desired research outcomes are. We intend to encourage them to be more involved, perhaps by active collaboration in or support of the research.

In developing our research agenda we considered input concerning research needs from EPA Region 6 in Dallas; the El Paso Border Office of the EPA; the Texas Natural Resource Conservation Commission; the Texas Water Development Board; the Environmental Defense Fund; the "Research Needs of Texas State Agencies" published by the Texas Higher Education Coordinating Board; and the joint SCERP/Region 6/Region 9/EPA Headquarters research priorities developed in Dallas in December 1994. We also considered input being developed as part of the then-ongoing Border XXI efforts of the EPA and its Mexican counterpart agency, SEMARNAP.

Our strategy for selecting research projects was to begin with a call for pre-proposals which we would screen for need and relevance to recognized environmental issues. After the

relevance/need screening we would invite selected researchers to submit full proposals which would be subjected to peer technical reviews by experts outside the university. Proposals with satisfactory technical reviews would be considered for approval by the Director, CERM, with the concurrence of our project officer in ORD.

In October, we published a program announcement that called for research pre-proposals. Twenty-nine pre-proposals were submitted by members of the UTEP faculty and were screened by CERM and by the staff of EPA Region 6. (We wish to express our thanks to Norman Dyer and Gina Weber of the Region 6 staff for their special efforts in coordinating these reviews.) The CERM screening evaluation committee selected nine projects which were invited to continue competition for funding.

In 1996 these nine project proposals will be peer reviewed. Selection of projects for award of funds should be completed in time to begin research during the summer of 1996.

Environmental Justice Initiative

We have received approval from the administration to establish an Environmental Justice Initiative, working in conjunction with UTEP's Chicano Studies Program. We will develop papers, monographs, presentations and outreach programs which focus on adverse environmental impacts on low-income, border minority populations. C. Wesley Leonard, Associate Director of CERM, continues to serve on the EPA Region 6 Environmental Justice Task Force.

CERM Actively Pursues Other Sources of Funding

The Center seeks funding opportunities that are in consonance with its mission. During the last year we have secured additional funding, exceeding $2.5 million, from a variety of federal, state, and private sources. Some of these sources are: the Department of Energy, the Southwest Center for Environmental Research and Policy, EPA Minority Academic Institution Traineeships, the National Aeronautic and Space Administration, the Historically Black Colleges and Universities/Minority Institutions Consortium, the Corporation for National Service (AmeriCorps), Johnson and Johnson Company, the Ford Foundation, and a variety of state programs.

Student Support

Student support is one of the cornerstones of our foundation. We wish to provide opportunities for our culturally diverse student body to study to become environmental scientists and engineers and to work on relevant environmental projects and activities while they are studying. In 1995 we provided financial support to more than 100 students through part-time jobs and stipends.

Students receiving support through our Environmental Scholars program are required to meet requirements of enrollment and maintain academic proficiency. In addition to their specific project assignments, they are required to attend environmental seminars and colloquia, to perform environmental public service, and to compete in CERM's annual poster competition.

CERM Home Page on the World Wide Web

In summer we purchased and installed a computer station to function as the server for the Center's Home Page on the World Wide Web of the Internet. Our page was designed and developed by Mr. Oliverio Covarrubias, a graduate student working towards his Master's Degree in Computer Science. He is also a part-time member of our staff. Our home page tells the world about our Center and its mission, organizational structure, and staff. In addition it provides information about our programs and projects. We view the home page as an excellent method of disseminating information and transferring technology. The home page's Internet address is *http://www.cerm.utep.edu*.

Geographic Information Systems (GIS)

The Center worked to address a perceived weakness in the University's environmental capabilities by coordinating the development of Geographic Information Systems. In August we hosted a coordination meeting on GIS, inviting users and potential users to share information about their capabilities and plans. Recognizing that GIS systems can be expensive, we sought to find ways that the various academic disciplines can economize by using shared resources. CERM has become the University's coordinating center for GIS development. We continue to work closely with UTEP's Pan American Center for Earth and Environmental Studies and

Texas Centers for Border Economic Development to make GIS technology available to appropriate environmental programs.

In addition, CERM is working with several local governmental agencies to establish a regional GIS consortium for the El Paso community. The Center, in conjunction with the El Paso Water Utilities, the Central Appraisal District, and the Planning Department of the City of El Paso, is developing a memorandum of understanding which would form the consortium. Central to the consortium is a GIS service center to be based at UTEP using the University's developing capabilities.

Pan American Center for Earth and Environmental Studies (PACES)

PACES was created in 1995 as a consequence of the funding of a cooperative agreement between NASA and UTEP as part of the Mission to Planet Earth Program. A multi-disciplinary center, PACES conducts Geoscience, Computer Science, and Environmental Science and Engineering Research using remote sensing information available from NASA. PACES is assigned as a subordinate center of the Center for Environmental Resource Management. In addition, CERM's Director, Dr. Chip Groat, is the Chief Environmental Scientist for PACES.

Other CERM activities

CERM is involved in a wide variety of activities, working with other federal agencies (e.g., Department of Energy, the Bureau of Reclamation); state and local government agencies; national and local non-governmental agencies; corporate and private concerns; and binational organizations and groups.

Support of Region 6, the Border Office, and Texas Natural Resource Conservation Commission (TNRCC) . CERM has established good working relationships with EPA Region 6, the EPA Border Office in El Paso, and TNRCC, both in Austin and El Paso. When necessary, we have assisted these agencies in the conduct of their business in El Paso. For example, CERM supported the EPA Border Office and the State Department by providing a meeting hall at UTEP for a public hearing on the proposed Chevron gasoline pipeline under the Rio Grande. CERM supported Environmental Scholars also videotaped that meeting as part of their public service requirement.

EPA Cooperative Agreement on HAZTRAKS. CERM has a cooperative agreement with EPA Region 6 to assist them with a project designed to enhance the abilities of both the U.S. and Mexican federal and state environmental enforcement agencies to communicate about hazardous waste movement in and out of the border region. Specifically, CERM is working with the EPA and Mexico's SEDESOL to equip the northern Mexican border state environmental offices with computers, software and modems to electronically transfer information to and from the U.S. and Mexican central environmental databases. This project is important to U.S.-Mexico relations in general, and cross-border environmental protection activities in particular.

In 1995 CERM staff members Eric Hutson and Oliverio Covarrubias procured and installed computers and network equipment which they installed in seven locations in Mexico. CERM also hosted a number of HAZTRAKS coordination meetings and conducted several training work shops for U.S. and Mexican users of the system.

In a related effort, CERM sponsored and coordinated a project to correlate U.S. and Mexican hazardous waste definitions and codes. This effort continues, and promises to be very important in the management of hazardous materials in the transborder region.

Transboundary Resource Inventory Program. The Transboundary Resource Inventory Project (TRIP) is working to create the first publicly accessible, standardized spatial data inventory and geographic information system (GIS) of natural resources and environmental indicies of the US-Mexico border.

The US-Mexico border region is one of the most complex and active borders in the world. This stretch of land encompasses more than 2,000 miles of shared natural resources, interconnected economic activities, and diverse social problems. These three components need to be address in order to ensure sustainable development of the region as a whole.

Today, one of the most common tools that governments, private industry, academic institutions and NGO's, have for policymaking and natural resources assessments are Geographic Information Systems. One of the bottle necks of GIS development is the availability of accurate, high quality cartographic data. In addition, for the US-Mexico

border situation, this problem is complicated by the fact that almost all cartographic efforts of both countries stop at the border, with little concern of the continuity of many conditions and processes such as soils, weather patterns, topography, infrastructure, populations, etc. In addition, many classification schemes used by the US and Mexico are often incompatible, representing an extra barrier for the development of GIS that can start to address many of the environmental problems of the border region.

In response to this need, universities, state and federal agencies from both sides of the border are working to create and implement TRIP. TRIP will encompass, or at least complement, on-going and proposed initiatives, and will lead to the development of a standardized, "user friendly" Geographic Information System for border region. Such a GIS will include relevant software applications, distributed spatial databases, related non-spatial databases, document sets and methodologies to guide compilation, storage and update - all tailored to resource information consumers, whose needs are to have easily accessible and up to date information.

CERM's director, Dr. Chip Groat, is a member of the TRIP Board of Directors.

Intergenerational EPA/AmeriCorps Ground Water Protection Program: El Paso, Texas, Wellhead Protection Project. This project links 20 UTEP students with retired senior volunteers to map and record locations of public water wells, and to survey and document potential sources of pollution that could contaminate those wells. The AmeriCorps program is administered by the Corporation for National Service, with the EPA acting as our "parent organization." The goals of the program are threefold: community service, community development, and development of the AmeriCorps members.

Escuelas Hermanas. The purpose of *Escuelas Hermanas* (English translation: Sister Schools), is to create an environmental consciousness in students living on the border in both nations, making them aware of the need to protect shared environmental resources through pollution prevention and conservation. The program, funded by the EPA Region 6 and administered by CERM, focused on water quality and consisted of two phases: the first adapted and/or translated currently available water quality curricula to accommodate binational and bicultural differences for use in high

schools in both El Paso, Texas and Ciudad Juarez, Mexico. This curriculum was offered to teachers in a series of workshops and laboratory exercises conducted at UTEP. The second phase involved the teachers and their students conducting field research projects to investigate water quality on both sides of the U.S.-Mexico border using both established environmental testing techniques, as well as new techniques developed for the project. The students came together to present their findings to their peers and the community at the end of the project. The integration of these methods into a high school curriculum heightened the awareness of environmental issues in the target population.

Aqua Para Beber. *Agua Para Beber* (English translation: Drinking Water) is a binational community-based program for improving water quality and promoting safe hygiene practices in low-income border communities. The program combines a hygiene education and water purification program with the distribution of low-cost, simple technologies. The program was piloted in 1994 in six communities (three in El Paso County, Texas and three in Ciudad Juarez, Chihuahua, Mexico) and involved training 51 volunteer health promoters who worked with over 500 families in the initial effort. *Agua Para Beber* is currently being transferred to community-based organizations. This allows the program to achieve a greater multiplier effect, reaching the largest number of families possible, and to enhance program sustainability. As a result of partnering with local organizations, the program will reach an additional 1,000 families (approximately 5,000 individuals) in the Cd. Juarez and El Paso area by the summer of 1996. CERM will continue to expand the program in Cd. Juarez/El Paso area and beyond to meet the needs of the disenfranchised border residents who lack services. The ultimate goal of the program is to help improve the safety of drinking water, and thus, the quality life for residents of the entire border region.

Agua Para Beber is funded by the U.S. Environmental Protection Agency through the Southwest Center for Environmental Research and Policy (SCERP) and Johnson & Johnson Co.

Binational Water Program. The Binational Water Program/ Programa Binacional del Agua (BWP/PROBIDA) is a cross border program designed to address water issues in the El Paso/Cd. Juarez/Las Cruces region. It is funded by a grant from the Ford Foundation.

The program seeks to address regional water concerns via an integrated approach that involves planners, policy makers, researchers, and users. Since its inception, meetings have been held to discuss regional water concerns and to plan for future resource needs. In addition, legal and technical documents, policy papers, and maps have been collected for a binational database and library. Currently the program is focusing on facilitation of dialogue among water entities and promotion of the concept of joint water planning and management.

Participation in the Paso del Norte Air Quality Task Force . CERM staff members participate in the Paso del Norte Air Quality Task Force. This body meets quarterly to bring public, corporate, non-governmental and academic stakeholders together to share information and concerns about the El Paso - Juarez airshed. Several projects have been funded through the task force including diagnostic emissions training in Juarez technical/vocational schools, brick kilns using bottled gas fuels, and GIS inventories of point source pollution in Juarez (e.g., cement factories, paint and body shops). This group is working with EPA and the State Department and their Mexican counterparts to establish an international Air Quality Management Basin (AQMB). This model agreement is considered the first of its kind and important to the implementation of NAFTA environmental goals.

DOE Clean Cities Program. On November 17, 1995 the Paso del Norte clean cities coalition made up of El Paso County, Juarez, and Southern Dona Ana County, New Mexico, became the first international designation in the U.S. Several business, academic and governmental entities have committed to alternative fuel use to alleviate air contamination. DOE will promote the program through a $10,000 Paso del Norte Clean Cities Marketing and Promotional Campaign and help the region receive its share of a $50 million fund (funded by the Texas Alternative Fuels Council) to develop an alternative fuels/alternative fuel vehicles infrastructure.

Good Neighbor Environmental Board . The Good Neighbor Environmental Board is an advisory board to the President and Congress. Managed by EPA, the Board meets 2-3 times a year to produce an annual report highlighting environmental priorities. In EPA’s Border XXI five-year plan, the Board and its counterpart in Mexico are asked to provide input to EPA on Border XXI annual work plans. CERM director Dr. Chip Groat is appointed to the Board; program coordinator Jan

Hartman serves as an alternate.

HBCU/MI Environmental Technology Consortium . CERM administers UTEP's participation in the Historically Black Colleges and Universities/Minority Institutions Environmental Technology Consortium, funded by the Department of Energy. The program seeks to build institutional capacity in areas of Environmental Technology and Waste Management and is based on minority student recruitment and retention, as well as curriculum and faculty development to provide a higher level of academic options for students. Funding, which expires in 1997, is available for student stipends for environmentally related research projects; faculty development; and curriculum development. Consortium supported students have faculty mentors and are members of the Energy and Environment Scholars Program. A sub-grant in environmental curriculum development ("The Natural Step") is pending. If approved, 40 faculty from various disciplines will be trained in this systems approach to environmental literacy.

Southwest Center for Environmental Research and Policy(SCERP). UTEP is a member of this consortium of five US and four Mexican universities. SCERP addresses the full-range of environmental issues that confront the border through a program of research, training, education, outreach and policy studies. SCERP is funded through a congressionally-mandated cooperative agreement with the EPA . Historically, the consortium has received about $2 million a year. UTEP has received support for a number of research and outreach activities during SCERP's first five years.

CERM administers UTEP's participation in SCERP and C. Wesley Leonard, our Associate Director, is a member of SCERP's Management Committee. In 1996 the chair of the management committee will rotate to UTEP.

Our goal is coordinate CERM's efforts to work synergistically with SCERP. A listing of UTEP research projects funded by SCERP is found at the table at the end of this section.

Sustainable Development Initiative for the Rio Grande/ Rio Bravo Basin. UTEP, El Colegio de la Frontera Norte, the Houston Advanced Research Center, University of New Mexico, and the Universidad Autonoma de Nuevo Leon, have joined together to address the question of development and water resources in the Rio Grande/ Rio Bravo Basin. This

project, the Sustainable Development Initiative for the Rio Grande/Rio Bravo Basin, works at the grass roots level to form working groups throughout the basin to look at issues related to regional sustainable development.

The concept of sustainable development asks individuals to link economic development to environmental and natural resource concerns to determine what kind of development is best suited for the region. Working group participants are developers, industrial and business representatives, agricultural users, environmentalists, biologists, lawyers, policy makers and researchers who come together to discuss issues related to regional sustainable development and to promote the concept of sustainable development at the local level.

Highlights for 1995

- New director -- Dr. Charles G. Groat.
- Approval and implementation of interdisciplinary Ph.D. in Environmental Science and Engineering. Sixteen students are currently enrolled.
- Ten environmental research projects underway during the year.
- Implemented an innovative Faculty Development and Planning Grant Program during the summer. Eight new faculty members worked on seven grant programs.
- New focus on client-driven research to provide near-term solutions to critical environmental problems affecting the Paso del Norte region.
- CERM sponsored an environmental research project at another regional institution with a significant minority enrollment -- The University of Texas at San Antonio conducted a pilot project involving bioremediation of chlorinated alkenes and chlorinated benzenes.
- CERM established a presence on the World Wide Web of the Internet (*http://www.cerm.utep.edu*)
- Recognition of CERM sponsored researchers and their students -- Dr. Jorge Gardea Torresdey and his students were invited to present papers at the Hazardous Substance Research Center conference in Manhattan, Kansas.
- Leveraged EPA’s investment by obtaining more than $2.5 million in additional funding from a variety of federal, state, local and private sources
- Supported more than 100 students who are studying to be environmental scientists and engineers. Provided them opportunities to work on technical, policy, outreach and education projects that address environmental problems and issues.

Plans for 1996

- Develop a close and cooperative working relationship with the El Paso Border Office of the EPA to address the EPA's Border 2000 objectives.

- Revitalize the Center's External Advisory Council and use it to further corporate and private support for elements of the Center's activities.

- Continue to encourage binational cooperation in addressing the areas environmental problems.

- Continue to emphasize client/end-user involvement and collaboration in our research activities.

- Develop and implement a regional recruiting program for ESE Ph.D. students.

- Firmly establish the University as the focal point for GIS development and activity for the community and the region.

- Increase utilization of CERM's World Wide Web home page to continue to disseminate information about our programs and environmental issues.

- Strengthen current and develop new partnerships with U.S. and Mexican federal, state, and local agencies and organizations, and other regional universities, to enhance our collective ability to address environmental problems.

- Establish, in conjunction with UTEP's Chicano Studies Program, the Environmental Justice Initiative to address the adverse impact of environmental conditions on low-income, minority residents of the region.

- Establish a CERM-based research program addressing surface to ground water and surface water/ground water interactions staffed by UTEP and visiting scientists and engineers with emphasis on defining and mapping pollution vulnerability.

- Initiate a GIS-based environmental atlas of the El Paso-Juarez region with the identification and mapping of land-use practices with the highest risk of polluting surface and ground water supplies.

PROJECT LISTS

Projects supported by Cooperative Agreement CR 819849-01			
Proj No.	**Principal Investigator**	**Project Title**	**End Date**
	Full-scale Research Projects		
SF1	M.C. Robbins, Ph.D., Dept of Mech & Ind Engr	Investigation of Heat and Mass Transfer in Hazardous Substance Containment Facilities	Aug 95
SF2	J. Walton, Ph.D., Dept of Civil Engr	Flow Through Flaws in Impermeable Barriers	Aug 95
SF3	W. Herndon, Ph.D., Dept of Chemistry	Octanol/Water Partition Coefficients	Dec 94
SF4	C.R. Bath, Ph.D., Dept of Pol Sci	Environmental Justice, Hispanics, and the Disposal of Hazardous Wastes in the El Paso Region	Aug 95
SF5	J. Walton, Ph.D., Dept of Civil Engr	Long-term Performance of Cementitious Waste forms in the Unsaturated Zone: the Role of Soil Gasses.	May 96
SF6	P. Goodell, Ph.D., Dept of Geology	Bioremediation of Chromium in Contaminated Soils and Potential Application to the Bioremediation of Cr(vi) Contaminated Sites	May 96
SF7	R. Webb, Ph.D., Dept of Biology	Cyanobactorial Bio-reactors for Removal of Heavy Metals from Contaminated Soils and Streams	May 96
SF8	J. Gardea-Torresdey, Ph.D., Dept of Chemistry	Removal and Selective Recovery of Heavy Metal Ions from Superfund Sites Using Biological Materials	May 96
SF9	J. VanDerslice, Ph.D., School of Public Health (Univ of Texas Health Sci Ctr at Houston, El Paso satellite program)	Development of Risk Assessment and Risk Communication Methods for the US-Mexico Border	Dec 95

	Preliminary Studies		
UTSA	N. Guentzel, Ph.D., Division of Life Sciences, University of Texas at San Antonio	Biodegradation of Chlorinated Alkenes and Chlorinated Benzenes by Aerobic Microbial Metabolism	Dec 95
	UTEP Faculty Development and Planning Grants		
PG 95-1	W. Weaver, Ph.D., & P. Frederickson, Ph.D., Dept of Political Sci	Developing Model Legal Agreements and Management Strategies for Environmental Protection on the U.S.-Mexico Border	Aug 95
PG 95-2	J. Peterson, Ph.D., & P. Vila, Ph.D., Dept of Sociology and Anthropology	The Human Resources of the Rio Grande Ecosystem: Evaluating Human/Environment Interaction and Management Options in the Desert Borderlands	Aug 95
PG 95-3	R. Quintana, Ph.D., Dept of Mech & Ind Engr	Minimization of Border Manufacturing Hazardous Waste Generation	Aug 95
PG 95-7	J. Clingermayer, Ph.D., Dept of Pol Sci	State Politics, Administrative Context, and the Siting of Hazardous Waste Facilities	Aug 95
PG 95-12	K. Miller, Ph.D. Dept of Geological Sciences	Potential Role of Controlled-Source Seismology in Evaluating Direction of Fluid Flow and Contaminant Migration in Arid Regions	Aug 95
PG 95-13	G. Ohlmacher, Ph.D., Dept of Geological Sciences	Recharge Potential and Environmental Protection of Mountain Front Recharge Areas in the El Paso, Texas Region	Aug 95
PG 95-14	E. Walsh, Ph.D., Dept of Biological Sciences	Pilot Study: Determination of the Ability of the Rotifer *Brachionus Calyciflorus* to Bioaccumulate Toxicants from Freshwater Ecosystems	Aug 95
	Other		
WWW	E. Hutson & O. Covarrubias, CERM	Establishment of an Internet World Wide Web Node	Dec 95

UTEP Projects Funded by SCERP				
Proj No.	SCERP Year	Title	PI	Status
W1	1	Binational Study of Water Requirements and Resources in the El Paso/Cd. Juarez Region	Dr. Stephen Riter	Complete
W3	1	The Rio Grande River as a Potable Water Source: An Evaluation of Anthropogenic Contaminant Occurrence, Fate, Removal, and DBP Formation	Dr. Charles Turner	Complete
W6	1	Rio Grande Sediments: Adsorption and Desorption of Strontium, Lead, and Cesium	Dr. Hector Fuentes Dr. Charles Turner	Complete
W14	2	Disinfection By-Product Removal from Recycled Waste Water	Dr. Anthony J. Tarquin Dr. Charles Turner	Complete
W15	2	Eco-Toxicological Impact of Agricultural Chemicals on the Rio Grande Corridor	Dr. Roger Case Dr. Carl Lieb	Complete
W16	2	Characterization of Unsaturated Zone Geological and Hydrological Properties in the El Paso-Juarez Border Region	Dr. Mark R. Baker	Complete
H6	1	Exploring Some Fundamental Issues in Corrosive Waste/Container-Materials Interactions	Dr. L.E. Murr	Complete
P4	1	United States and Mexico Southwest Borderwide Environmental Problems, Needs and Action Priorities, (El Paso, Texas, April 24 & 25, 1991)	Dr. Donald A. Michie	Complete
P15 EH93-3	2-3	An Analysis of Lead Exposure During Pregnancy and the Neonatal Period Among Indigent Hispanic Women	Dr. Maria Amaya	Complete

P16	2	HAZMAT: Border Research and Policy Issues	Dr. Donald A. Michie	Complete
AQ93-3 AQ94-3.1 AQ95-4	3 4 5	Upper Atmosphere Wind and Temperature Profile Data for the El- Paso-Juarez Airshed	Dr. Jack Smith	Ongoing
MIEP AQ94-5.3 AQ95-2	3 4 5	Study of Brick Kiln Designs and Development of Technical Courses for the Brickmakers Training Center in Cd. Juarez	Nancy Lowery	Ongoing
WQ93-4 WQ95-4	3 5	The Provision of Safe Drinking Water for Low Income Border Communities Using Appropriate Water Purification/Waste Water Techniques	Wesley Leonard Amy Leibman	Ongoing
MIEP	3	Lead and Folic Acid Levels in Pregnant Women in Cd. Juarez	Dr. Maria Amaya	Complete
AQ94-1.3	4	Characterization of Border Crossing Vehicles	Dr. Ryan Wicker	Ongoing
AQ94-OF-7	4	Prevention of Air Contamination: VOC Reduction in Paint and Body Shops in Juarez	Jan Hartman	Ongoing
AQ95-1	5	Quantitative Analysis of Dynamic Video Images and Static Images of the Paso Del Norte Air Basin: Years 1992-1994	Dr. Chuck Turner Dr. Jim Parks	Ongoing
EH95-2	5	The Border Basket: Analysis of Toxic Metals in Retail Foods, El Paso-Juarez	Dr. Nicholas Pingitore Dr. Maria Amaya	Ongoing

Reports of Active Research Projects

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Project Title: **Investigation of Simultaneous Heat and Mass Transfer in Hazardous Substance Containment Facilities**

Principal Investigator: **Dr. Mary Clare Robbins, Ph.D.**

Goal: The main objective of the research is the development of a computational model for the prediction of simultaneous heat and mass transfer through a layered clay-plastic liner used in the containment of salt brine. The containment facility considered in this project is the El Paso Solar Pond. Heat and moisture transport characteristics of the composite liner are to be investigated *in situ* and in the laboratory. This information will allow for the appropriate functional representations of the transport properties of the clay and soil which are required for the computational model. The results of the computational model will be compared to experimental data obtained when operation of the solar pond begins.

Rationale: The primary objective of this research is the study of simultaneous heat and mass transfer within layers of composite porous media. Problems of simultaneous heat and mass transfer within porous media arise in many important engineering applications. The research to be conducted specifically addresses the problem of simultaneous heat and mass transfer occurring within porous media at elevated (40 °C - 100 °C) temperatures. Applications include hazardous waste storage at elevated temperatures and underground thermal energy storage. Examples include supplemental heat provided to buildings which use the underground storage as a heat source and salt gradient solar ponds that capture and store thermal energy for electricity production, process heat, and desalting applications. The proposed project will provide information regarding the movement of various substances through engineered barriers and lead to more reliable methods of containment.

Approach: Five tasks have been identified as necessary to develop the proposed research. These are the identification and evaluation of physical models of simultaneous heat and mass transfer; the determination of functional representations of the transport properties of the clay and soil; the selection of a numerical method to approximate the physical model and property functions; the development of the necessary instrumentation package for data acquisition; and finally, the comparison of the computational model with experimental results. Once the physical model has been selected, the appropriate functions for the representation of the transport properties including thermal conductivity and moisture diffusivity coefficients of the soil must be

determined. This step is important to the subsequent research because the properties of the soil and their variation with temperature and moisture content are major factors which influence the heat and mass transfer through the liner. The third step is the selection of a computational method to solve the nonlinear system of equations which will be developed during the first two phases of the research. The fourth phase of the research will be the development of an instrumentation package for data acquisition. A small scale experiment will be set up in the laboratory so that actual experimental conditions may be closely approximated. The development of an acceptable and reliable instrumentation package includes: selection of sensors for temperature, moisture content, and heat flux; installation of a data acquisition system; and, calibration of the sensors during an experimental trial.

Clearly, comparison of the physical-numerical model by experimental results is of extreme importance. Since this research project will be conducted at The University of Texas at El Paso where a new salt brine containment pond facility is under construction, experimental verification of the research will be in the examination of heat and mass transfer using this facility. The project will provide information regarding the movement of various substances through engineered barriers and lead to more reliable methods of containment.

Status: Since there have been schedule changes for the El Paso Solar Pond Project, the site for this study, the schedule for this project has been modified appropriately. It was decided to replace the compacted clay liner (CCL) which was originally proposed with a geosynthetic clay liner (GCL). The GCL system has several advantages over the CCL including ease of installation. The main activity initially focused on research concerning the appropriate installation of the GCL. The selection of the GCL system necessitated a change in the instrumentation system. During the past year we have focused on the design and installation of an instrumentation package for data acquisition. These activities were originally proposed for the last three months of the project. Instrumentation was designed and developed to measure temperature in the soil underneath the pond. An undergraduate student created thermopiles which were placed in both a test strip (an on-site experimental set-up) and in the pond itself. Commercially available instrumentation designed to monitor moisture potential was investigated, but it was decided that it was not appropriate for the task. A data acquisition system was selected which included a plug-in data acquisition board and a computer system. The data acquisition system has been installed and is currently collecting temperatures of the ground beneath the pond.

A computer program has been identified which should adequately model the flow of heat and moisture below the lining of the pond, and can be used for the comparison with the experimental results which will be obtained when the pond is operational. Numerical experiments are currently being performed using the computer program. Although the project officially ended in August, temperature data continues to be collected and flow of liquid through the liner is measured. The hydraulic conductivity of the liner is evaluated using the flow data. The variation of hydraulic conductivity with temperature is still being investigated.

Potential Users / Technology Transfer: Operators of hazardous waste containment facilities

Other Personnel: Dr. Jack A. Dowdy, Dept. of Mech. & Ind. Engineering, The University of Texas at El Paso

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Project Title: **Flow Through Flaws in Impermeable Barriers**

Principal Investigators: **Dr. John C. Walton, Ph.D. and Dr. Miguel Picornell, Ph.D.**

Goal: The purpose of this study was to evaluate the end result of flaws in geomembranes using a combination of mathematical modeling and laboratory experiments. Former experimental studies did not investigate the physical processes controlling leakage rates around the proximity of a flaw. This experimental work was performed with gravel on top of the geomembrane, and failed to address the potential aforementioned processes. Moreover, this study also investigated how and when the thickness of the membrane influences the leakage rate. Low permeability material is usually used as a subbase to the geomembrane on top of a relatively higher permeable material. The experiments in this study were done for saturated steady state flow. Because of the lower permeability of the subbase material on top of a relatively more permeable media in the field, saturated flow is close to the real field condition.

Rationale: Previous modeling and experimental work have suggested a number of interrelated physical processes which can occur around the vicinity of the flaw and control leakage rate through an individual flaw. Potentially important processes include: flaws remain open; adjacent porous material is stressed and migrates to fill flaws, thereby lowering flow; gaps form between liner and soil, greatly increasing flow; and erosion of material around the flaw occurs, greatly increasing flow rates. It was, therefore, important to evaluate the changes in flow rate due to the different boundary conditions at or around the flaw.

Approach: The mathematical model developed was successfully used to explain flow through flaws in a laboratory system. The experiments found that gap formation appears to be inconsequential at burial depths greater than around 0.5m. Effective stress reduces or eliminates the gaps between the soil and the geomembrane and facilitates the infilling of the flaw with the adjacent porous material. When infilling occurs, thick membranes are more effective in reducing the leakage through flaws. Simplified equations, applicable to most field situations, were provided for quantification of leakage rates through flaws. Furthermore, it was found that the leakage rate for small flaws is independent of the thickness of the low permeability soil (clay liner) adjacent to the geomembrane.

Status: In addition to establishing that the literature currently being used to estimate flow through flaws erroneous and constructing a more suitable model to analyze flaws in geomembranes, several papers were published.

This research has been submitted to ASCE Journal of Geotechnical Engineering for publication on October 25, 1995.

Potential Users / Technology Transfer: In summation, this research work can be applied to analyze flow rate through flaws in geomembranes and any similar impermeable barriers (e.g., concrete, underground storage tank walls). Two of the paper results from the research are attached. The papers provide details of the research and effective results.

Other Personnel: Masudur Rahman, graduate research assistant; David Casey, graduate research assistan; Floyd Johnson, undergraduate research assistant.

Project Title: **Environmental Justice, Hispanics, and the Disposal of Hazardous Wastes in the El Paso Region**

Principal Investigators: **Dr. C. Richard Bath, Ph.D. and Dr. Howard D. Neighbor, Ph.D.**

Goal: To determine the extent to which government agencies have employed appropriate standards of environmental equity or justice in four environmental issue areas being studied: 1) the Silver City, New Mexico Superfund site, Cleveland Mill; 2) the Sunland Park, N.M. hazardous waste incinerator and landfill site; 3) the Texas Low Level Radioactive Waste Disposal Site in Hudspeth County; and 4) implementation of measures under the 1990 Clean Air Act to insure El Paso's compliance with emission standards for particulates, ozone, and carbon monoxide.

Rationale: The question of environmental equity, environmental justice, or environmental racism has recently become a major issue on the public agenda. Basically the question is to determine whether racial and ethnic minorities have suffered disproportionately in the siting of wastes. The purpose of this research is to: (1) determine the extent to which environmental equity played a role in the four case studies; and (2) determine how attitudes and perceptions of the participants led to feelings of inequity and to discover and develop alternative channels of communication and representation through which minorities can become aware of the possible consequences of a given hazardous waste disposal program and the EPA and state agencies can identify, understand and accomodate protest before a group becomes alienated.

Approach: At each case study we will document the sequence of events leading to controversy and interview the actors who were involved: scientists and engineers, government officials, commercial and media interests, along with public interest group representatives, and individual activists.

Status: We have terminated the research and will shortly present the Final Report to the EPA. Much of the background work was completed prior to this reporting period. Our activities since the beginning of 1995 are listed below:

1) In late January we attended an EPA/NMED Public Hearing on the Cleveland Mill Superfund site in Silver City, New Mexico. Interviews with EPA and NMED officials were conducted. In the course of this trip we became convinced that Cleveland Mill did not fundamentally involve a question of environmental equity. What was evident was a

rigorous procedural process on the part of EPA/NMED to insure compliance with CERCLA and with the Executive Order on environmental equity. We were particularly impressed with the project directors for both EPA and NMED who did evidence awareness of the equity issue and actively pursued it in the administrative process.

2) In February we again traveled to Austin where we interviewed appropriate officials with the Texas Low Level Radioactive Disposal Authority and the Texas Natural Resource Conservation Commission. In spite of some friction with the Director of the TLLRDA we received cooperation from that agency. The basic problem is that representatives of that agency did not understand the concept of institutional racism offered by Professor Neighbor as a partial explanation for the location of the disposal site in Hudspeth County.

Interviews were also conducted with appropriate officials in the TNRCC dealing with the problem of air pollution in El Paso. They are well aware of the issue of environmental equity involved in the application of the Clean Air Act to El Paso but did not, at the time, regard it as a major deterrent to implementation of the 1990 Act.

During this same time frame the state of Texas and the EPA became locked into a battle over state implementation of the Clean Air Act and the state of Texas suspended compliance with the Act pending appeal and review by EPA. New-Governor Bush sanctioned the EPA for failing to take into consideration the unique international setting of El Paso's air pollution problem. As a result, Texas refused to implement the required centralized mandated vehicle testing program required for El Paso, Dallas, and Houston and has opted for maintaining the less-rigorous decentralized testing program. A decision from EPA on testing is expected some time in September 1995. In several meetings with representatives of Congressman Coleman's office, Mayor Larry Francis, and others, the issue of environmental equity as applied to air pollution compliance on the part of El Paso was raised but the question of equity played a very minor role in both the city's and state's opposition to the mandated program.

3) In early March both Professsor Neighbor and Professor Bath traveled to Region VI headquarters to interview EPA officials on separate occasions and over separate issue. Professor Neighbor interviewed EPA officials over the question of the Cleveland Mill site and over the Sunland Park landfill site. Professor Bath interviewed officials over the air pollution implementation program and the Sunland Park disposal site. In all cases the commitment

of Region VI to the question of environmental equity was regarded as sincere but somewhat perfunctory.

4) In April Professor Neighbor presented a paper in the Association of Borderlands Scholars of the Western Social Science Association Annual Meeting on the Cleveland Mill site; Professor Bath presented a paper on the Sunland Park disposal site at the same conference. By this time all the background case studies had been completed and all that remained was further interviews, mainly with New Mexico officials.

5) In May Professor Neighbor traveled to Santa Fe for interviews with NMED people on Cleveland Mill. Also interviewed were the environmental equity officers for New Mexico.

6) In August Professor Bath traveled to both Las Cruces and Santa Fe for interviews with New Mexico offcials over the Sunland Park disposal site.

7) Currently the Final Report for EPA on the project is being written and will be finished prior to the end of August. As a guideline the EPA's strategy for environmental equity is being applied to the four case studies.

Potential Users: Various governmental agencies and public interest groups.

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Project Title: **Long Term Performance of Cementitious Wasteforms in the Unsaturated Zone: The Role of Soil Gasses**

Principal Investigators: **Dr. John Walton, Ph.D. and Dr. Anthony Tarquin, Ph.D.**

Goal: To research the effect of carbonation on leaching of cementitious wasteforms, and develop conceptual and mathematical models from the experimental data to describe carbonation effects.

Rationale: Cement-based wasteforms are among the most commonly used waste disposal and site remediation options. However, concrete knowledge of the processes controlling long term performance of the wasteforms is lacking. The presence of carbon dioxide in soil gasses can result in carbonation during underground storage. It is therefore important to see how this process affects leaching of wastes into the water table. Knowledge of how the leaching rate is affected by CO2 concentrations in the atmosphere can be very useful in modeling of this process, which in turn will allow for better informed decisions on the proper remedial actions to be taken.

Approach: In the United States wastes are required by law to be placed in the unsaturated zone. In the laboratory, performance of the wasteforms is evaluated using fully water-saturated conditions. The presented research combines an experimental and modeling program approach to evaluate the role of the carbon dioxide reactive component of soil gas on the long-term performance of cementitious wasteforms. Cementitious wasteforms containing large concentrations of ions were cast and exposed to an accelerated environment for carbonation then subjected to leaching tests. The leachate was then analyzed for various contaminants including: lead, strontium, cadmium, cobalt and nitrate.

Status: Carbonation and leaching test of the cementitious wasteforms have been completed and a mathematical model has also been developed. In addition, analysis of most of the contaminants has been completed. Three rounds of leaching tests were performed. The first round of tests was conducted in order to determine the ion concentration in the contaminant necessary to obtain detectable concentrations in the leachate. In the second round of tests all metals except Strontium were found to be at or below the detection limits of the analytical equipment available in both the carbonated and control samples. In the third round of tests a more aggressive environment was created by using acetic acid as the leaching medium.

This was done in order to obtain higher quantities of the metals in the leachate. Results are analyzed by comparing the experimental data with theoretical models of the leaching process. Analyses have shown that carbonation results in increased diffusion for nitrate, while retarding it for metals such as strontium. The net result of carbonation may be to either increase or decrease the contaminant release rate and depends upon the specific contaminant of concern.

Potential Users / Technology Transfer: Potential users could be any private industry or public entity which can use solidification and stabilization with cementitious materials as a waste management option.

Other Personnel: Dr. Robert Smith, a geochemist at the Idaho National Engineering Laboratory has assisted with the project. Dr. Smith and Dr. Walton previously developed model for the effect of solid solution in calcite on leaching from carbonated wasteform.

Project Title: **Bioreduction of Chromium in Contaminated Soils and Potential Application to the Bioremediation of Cr(VI) Contaminated Sites**

Principle Investigator: Dr. Philip Goodell, Ph.D.

Goal: The overall objective of this study is to determine what soil physical, chemical and biological factors control the speciation and thus, mobility and toxicity of Cr in contaminated soils.

Rationale: Soil, sediment, and groundwater are often contaminated with chromium, and at high concentrations Cr is toxic and carcinogenic. Cr(VI) exists as the chromate anion, is much more mobile than Cr(III), and is more toxic. Cr(VI) reduction to Cr(III) will immobilize Cr. Some microorganisms can survive in environments contaminated with high concentrations of Cr, and enzymatically reduce Cr(VI) to Cr(III). The hypothesis of this study is that microorganisms play an important role in determining the speciation of Cr, and thus its toxicity and mobility, in soils and sediments. However, past studies of the speciation and fate of chromium in the subsurface have largely ignored microbial processes. It is anticipated that soil microorganisms can be biostimulated to enzymatically catalyze the reduction of Cr(VI). This could lead to the development of new bioremediation technologies for Cr-contaminated Superfund sites. Bioremediation is potentially a less expensive cleanup method than those currently used, and one that could be used without adding more toxic chemicals to the environment.

Approach: Samples were collected from several Cr(VI) contaminated sites. These were analyzed microbiologically and chemically. The genetic potential for Cr reduction was correlated with Cr content. The soil from each site was used in batch culture studies to determine the potential for biostimulating the reduction of Cr(VI) in contaminated soils.

Status: Surface soil samples were collected from 4 sites. National Chromium and Leigh Metals are located in Odessa, Texas and are former chrome plating facilities currently listed as Texas Superfund sites. Uncontaminated control soil was collected from two different locations. All soil samples were digested in hydrochloric acid and hydrogen peroxide, and then analyzed by ICP for selected heavy metals. At both contaminated sites no other heavy metals were present at contaminant levels. The concentration of soil total Cr

at Leigh metals was 100 mg kg^{-1} and at National Chromium the concentration was 29,600 mg kg^{-1}.

Cr(VI) resistant bacteria were isolated both directly from the soil and after an aerobic enrichment procedure. Bacterial populations resistant to as much as 500 mg L^{-1} Cr(VI) were directly isolated from Leigh Metals and both uncontaminated control (20 mg kg^{-1} total Cr) soils, but none resistant to this concentration were directly isolated from National Chromium soil. The numbers of bacterial colonies resistant to 100, 250, and 500 mg L^{-1} Cr(VI) isolated from Leigh Metals, Control 1, and Control 2 soils were approximately the same. These results indicate that if Cr-tolerant microorganisms are present in uncontaminated soils, the genetic potential for bioremediation may be present in most soils, uncontaminated as well as contaminated. This is contrary to previous suggestions that Cr-contaminated soils and sediments select for Cr-tolerant strains. To test the hypothesis that the genetic potential for bioreduction of Cr(VI) is present in most soils, another set of experiments was conducted to determine if microorganisms capable of mediating reduction of Cr(VI) to Cr(III) were also present in these soils. The slightly contaminated Leigh and both non-contaminated control soils were added to batch cultures spiked with 1000 mg L^{-1} Cr(VI). In these batch culture studies, Cr(VI) was reduced 24% (from 1000 mg L^{-1} to 750 mg L^{-1}) in the 2 control soils, and 30% (from 1000 mg L^{-1} to 700 mg L^{-1}) in the Leigh Metals soil.

A method for determination of Cr(VI) by ion chromatography was modified for our purposes. This method uses anion exchange to separate chromate anions from other chemical components, including Cr(III). After separation, chromate ion is then mixed in a post-column reactor to develop color, absorbance measurement is then used to quantify chromate. This method is an improvement over the commonly used diphenylcarbazide colorimetric method.

Soil collected from the heavily contaminated [10,000 mg kg^{-1} Cr(VI)] National Chromium Superfund site was used in batch culture studies to determine if the indigenous microbial populations could aerobically reduce Cr(VI) to Cr(III). Cr(VI) concentrations in the soil solutions were reduced 35% (from 2,000 mg kg^{-1} to 1,300 mg kg^{-1}) under enrichment conditions. Cr(VI) reduction was found to be biologically mediated. Thus, results indicate that microbial communities in highly Cr contaminated soils can be significantly stimulated to reduce Cr(VI).

Previous studies have suggested that high organic content of soils is associated with chromate reduction. In one of these studies, it was reported that Cr(VI) in

water was reduced to Cr(III) when applied to soil amended with cow manure. It could be inferred from this study that soil amended with sewage sludge, with its high microbial diversity and organic carbon content, would also facilitate reduction of Cr(VI) in irrigation water. Aerobically and anaerobically digested sludge was added to some enrichment cultures containing soil from the National Chromium site to determine if increasing the microbial diversity would increase the rate of chromate reduction. Surprisingly, chromate was not reduced in enrichment cultures which also received sludge . It appears that abiotic components in sewage sludges inhibit aerobic bioreduction of Cr(VI). Our results indicate that sewage sludge would probably not be useful for this type of bioremediation.

Indigenous fungal populations resistant to 1,000 mg L^{-1} Cr(VI) were routinely isolated from all soils. A fungi resistant to 2,000 mg L^{-1} Cr(VI) isolated from the National Chromium soil was used in a batch culture study to determine if it could also mediate chromate reduction. Cr(VI) was reduced 60% in cultures initially containing 500 mg L^{-1} (to 200 mg L^{-1}), 30% in cultures initially containing 1,000 mg L^{-1} (to 700 mg L^{-1}), and 20% in cultures initially containing 2,000 mg L^{-1} (to 1,600 mg L^{-1}). The rate of chromate reduction was the same in all cultures, irrespective of the initial chromate concentration. Thus, these results indicate that indigenous fungal populations within Cr contaminated soils might be a biologically significant component of community structures capable of intrinsic bioremediation.

The first stage of a bioremediation project is to determine if the organisms with the genetic ability to mediate the desired transformation are present. One commonly used approach is the direct plate-count procedure. When soil from the National Chromium site was direct plated onto media containing 500 mg L^{-1} Cr(VI) no organisms grew. However, when this same soil was enriched, bacterial colonies were isolated which grew on media concentrations of 500 mg L^{-1}, and organisms grew in the enrichment cultures which contained concentrations of as much as 2,400 mg L^{-1} Cr(VI). In other words, although organisms resistant to as much as 2,400 mg L^{-1} Cr(VI) were present, the direct plate-count procedure indicated that none were resistant to concentrations of 500 mg L^{-1} Cr(VI). Previous studies have used the direct plate-count method to evaluate if indigenous Cr-resistant microorganisms are present in a contaminated soil, but it can be concluded from these results that using only direct plating approaches can be misleading.

A major setback for the project occurred in August 1995. The UV/VIS detector for the ion chromatograph failed and

the cost for replacement was $8,000. Funds were not immediately available and thus it was not replaced until December 20, 1995. This analytical device is critical to our research because it is used to quantify Cr(VI). Therefore, the experimental portion of the project was mostly on hold for 5 months.

Potential Users / Technology Transfer: EPA remediation efforts.

Other Personnel: This work is being done with Dr. Suresh Pillai and Dr. Medhi Ali, Texas A&M Research Station, El Paso, Texas.

Project Title: **Cyanobacterial Bio-Reactors for the Removal of Heavy Metals from Contaminated Soils and Streams**

Principal Investigator: **Robert Webb, Ph.D.**

Goal: The long range goal of our sub-project is to genetically engineer cyanobacteria to sequester arsenate at very high levels. The engineered cells can then be immobilized on solid supports to produce bioreactors capable of removing arsenate from contaminated solutions.

Rationale: The benefits of using cyanobacteria for this purpose is their multifaceted ability to deal with heavy metals and the fact that the major energy input for the proposed system will be sunlight. These organisms demonstrate natural abilities of arsenate uptake, reduction, metal binding to their calyx, incorporation of metal into polyphosphate granules and the binding of metals to metallothionines. These mechanisms can be mathematically modeled to determine the feasability of this approach to remediation once metal binding and gene expression parameters are determined and optimized.

Approach: We approach this project from a number of different but interrelated avenues. We are looking for proteins whose expression responds to arsenate stress. Some of these novel proteins may play a direct role in the tolerance to arsenate exhibited by the cyanobacteria. Our attempts to identify these proteins are done two ways; by direct examination of protein profiles and by an approach using genetic complementation. We are cloning genes whose protein products are known to participate in cellular responses to arsenate in attempts to overexpress them or destroy their function so as to increase arsenate accumulation inside cells. We are studying the function of various cyanobacterial gene promoters to identify arsenate responsive elements and strong promoters we may use to overexpress arsenate binding proteins. We will also examine the synthesis and properties of cyanobacterial polyphosphate granules since they could serve as an excellent sink for sequestered arsenate.

Status: Over the past year we have made significant progress in investigations of the responses of cyanobacteria to environmental stresses. The goals of these studies have been to understand better the molecular mechanisms involved in these responses at the levels of cellular physiology as well as gene and protein expression and to more thoroughly characterize the roles of proteins such as MapA and GroEL in these responses. These results provide insight into the mechanisms used in the assembly

of biological membranes and into mechanisms of nutrient uptake across membranes and into cells.

We have focused our attentions in this area primarily to the cyanobacterial responses to arsenate and arsenite. The arsenate ion resembles phosphate in geometry and size. It has been shown that arsenate is taken up by E. coli and Staphylococcus sp. cells via phospate translocators of the bacterial cytoplasmic membrane. Toxic effects of this ion may include perturbation of normal phosphate metabolism in reactions such as nucleic acid polymerization and the ATP utilizing reactions of the cell. These bacteria reduce arsenate intracellularly to less toxic arsenite and actively pump arsenite out of cells via an ATP dependent arsenite pump.

The cyanobacterial response to these compounds is dramatically different. All strains of cyanobacteria tested, are extremely resistant to arsenate when grown under normal conditions. We hypothesize that the normally expressed cyanobacterial phosphate uptake system can clearly distinguish between arsenate and phosphate so that arsenate never enters the cyanobacterial cells. When the cyanobacterium Synechococcus sp. PCC 7942 is grown for 6 days in the absence of phosphate in the culture medium, this organism exhausts its intracellular stores of phosphate (polyphosphate granules) and expresses a second, higher affinity phosphate translocation system. Under these conditions, Synechococcus sp. cells become sensitive to arsenate at levels comparable to sensitivities found for other bacteria. This effect is not due to phosphate starvation alone since these assays of growth are performed in the presence of added phosphate. We propose that the high affinity phosphate translocator does not distinguish phosphate from arsenate as clearly as the constitutive phosphate translocator. We further suspect that the cyanobacteria do not possess an arsenate reductase activity nor an arsenite pump.

Again in contrast to the situation found in other bacteria examined, the cyanobacteria are exquisitely sensitive to arsenite. We have shown that arsenite completely inhibits photosynthetic oxygen evolution immediately after its addition to active cells. Our hypothesis is that arsenite mimics carbon dioxide. This is consistent with the effects on oxygen evolution noted above and the fact that non-photosynthetic bacterial cells are unaffected by arsenite. Another possibility is that arsenite affects photosynthetic electron transport however, similarities between this process and bacterial, respiratory electron transport weaken this hypothesis.

We have isolated and characterized cyanobacterial strains from sites known to be contaminated with high levels of lead, cadmium and arsenic and compared the growth of

these strains in the presence of many metals to that of the laboratory strains Synechococcus sp. PCC 7942 and Synechocystis sp. PCC 6803 as well as to mutant Synechococcus sp. strains with genetically engineered lesions in the stress response genes mapA and groEL. The natural isolates show very high levels of resistance to all metals tested compared to published data concerning non-photosynthetic bacteria. We are attempting to more fully characterize these resistance mechanisms. The results concerning the mutant strains have been especially interesting. Deletion of the mapA gene confers increased resistance to metals while constitutive and uninducible expression of groEL causes a greater sensitivity to metals relative to wild-type cells. These studies will further our understanding of the role of GroEL in responses to environmental challenges and will help us define a precise cellular role for MapA (an iron limitation stress induced protein) in cyanobacterial metabolism.

Potential Users / Technology Transfer: Not yet Identified

Other Personnel: None

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Project Title: **Removal and Selective Recovery of Heavy Metal Ions from Superfund Sites Using Biological Materials**

Principal Investigator: **Dr. J. Gardea-Torresdey, Ph.D.**

Goal: The main objective of this project is the study of various species of alfalfa (Medicago sativa) for the removal of toxic heavy metal ions from contaminated waters (especially waters in superfund sites). Toxic metal binding by the alfalfa cells and also the immobilized cells will be investigated.

Rationale: Accumulation of toxic metal ions in water supplies is a matter of increasingly grave problem. Many ground and surface waters are currently contaminated with toxic metals and some contaminated sites have been classified as Superfund sites. At the present time, development of low cost innovative technologies for the removal of toxic heavy metal ions from waters is of great importance. We propose to study the metal binding capabilities of biologically-derived materials. Some plant species grow on soils heavily contaminated with toxic metals and are tolerant to the toxic effects of these metals. Thus, these plants may be biologically adapted to bind metal ions. Based on this criteria, we have identified alfalfa as a potential biological material for the removal of toxic metal ions from contaminated waters. Preliminary experiments in our laboratory have shown that alfalfa may have a strong affinity to bind metal ions. Four concurrent areas of research will be active:
1). Identification of toxic heavy metal ions present in Superfund sites in the State of Texas.
2). Bench scale laboratory batch experiments to study the binding properties of the identified metal ions to various species of alfalfa.
3). Study of metal binding to the immobilized biomass under flow conditions using a column technique.
4). Examine the possibility of removing toxic metal ions from actual contaminated waters from Superfund sites.
Our investigation results will provide valuable information into the application of an innovative technology (biological materials) for the removal and recovery of toxic metal ions from contaminated waters from Superfund sites.

Approach: This project consists of four phases. Phase one involves the investigation of Superfund sites in the state of Texas, which have waters contaminated with heavy metal ions. This phase will determine the metal ions which will be investigated. Phase two entails "batch" laboratory experiments to determine metal binding

capabilities of the various alfalfa species. Phase three consists of the study of metal binding to the alfalfa cells in a "column technique". The alfalfa biomasses will be immobilized in a silica matrix and the granulated polymer will be packed in columns to study their metal ion binding properties. Finally, the information gained in the previous phases will be required to perform phase four. Phase four will consist of performing metal binding experiments at optimum conditions using the column technique with the actual contaminated Superfund waters. Our investigation results will provide valuable information that may lead to an alfalfa-based innovative technology for metal removal and recovery from contaminated waters.

Status: We completed phase one, and have found 16 Superfund sites in the state of Texas to have waters contaminated with heavy metal ions. These metal ions include mercury, zinc, chromium, lead, copper, silver, barium, cadmium, arsenic, and nickel. Kirk Tiemann, who joined the project in August, has obtained his master's degree in chemistry, and this project has contributed to his thesis work. In addition, Jorge Gonzalez who joined our project in the fall of 1994 will also be per suing his master’s degree. In addition, Osvaldo Rodriguez has joined the project and will be per suing his bachelor’s degree.

Phase two of the project has been completed and the alfalfa varieties have been grown by Dr. John Henning research group at New Mexico State University. Dr. John Henning is an expert alfalfa breeder. Four pure alfalfa varieties (germplasms) were harvested. These pure varieties included the following germplasms: African, Flemish, Ladak, and Peruvian. In addition, two control varieties and a drought-stressed variety were harvested. One of the control varieties (Moapa) was grown along with the pure germplasms and the other (Malone) was grown separately. The drought resistant variety (Cal West-30) was grown under low irrigation conditions.

During this past year we have completed the batch laboratory experiments for the binding of Cadmium, Chromium III, Chromium VI, Copper, Nickel, Lead, and Zinc. Of the seven different populations of alfalfa studied, we have observed an optimal binding pH at approximately 5.0 and uptake time of less than five minutes for the metals studied. Batch laboratory experiments show that alflafa biomass is capable of efficiently binding these heavy metals with the exception of Chromium(VI).

During phase three, a “column technique” was utilized to study metal binding by the biomass under flow conditions. Gound alfalfa was entrapped in a Sodium Silicate polymer

to form a granular resin which was used as a “biofilter” in packed columns. Solutions of metal ions prepared in the laboratory were passed through six mL. of immobilized biomass (like ion-exchange resins) and analyzed to determine metal uptake. We have found that immobilized African shoots have the ability to remove Cadmium II, Chromium III, Copper II, Nickel II, Lead II, and Zinc II from solution. Repeated cycles of these experiments have been conducted for Copper ions on the same column to determine if the column can be reused. After twenty cycles the column shows no significant loss in efficiency. Interference studies were performed by using batch laboratory experiments to determine if naturally occurring Magnesium and Calcium ions will block heavy metal binding. Calcium and magnesium are prevalent ions in water that saturate commercial ion exchange resin filters. Batch laboratory experiments were performed with optimal binding pH and time to determine what the effects of differing hard water concentrations will have on the binding of heavy metals to the alfalfa biomass. Results from these studies show that calcium and magnesium do not significantly reduce the binding efficiency of Cadmium II, Chromium III, Copper II, Nickel II, Lead II, and Zinc II to African alfalfa shoots, even at concentrations as high as 8,000 ppm.

During this year, we have submitted two papers to the Journal of Hazardous Materials of our results for Nickel uptake by the different alfalfa populations, and for the study to remove copper ions from solution by silica immobilized alfalfa using the “column technique”. These two papers have been accepted and are now in press. The first paper sent to Solvent Extraction and Ion Exchange has been published. The students working on the project, Kirk Tiemann and Jorge Gonzalez, won two second place awards for research project competitions and also presented a poster and gave a seminar at the Tenth Annual E.P.A. Conference on Hazardous Waste Research. In addition, two papers from the presentations at the EPA conference at Kansas State University were published in the Proceedings of the Tenth Annual E.P.A. Conference on Hazardous Waste Research .

Potential Users / Technology Transfer: This could be a new innovative technology for the removal and recovery of toxic metal ions from contaminated superfund sites.

Other Personnel : Dr. J. A. Henning (Agronomy and Horticulture Dept., New Mexico State University)

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Project Title: **Development of Risk Assessment and Risk Communication Methods for the US-Mexico Border**

Principal Investigator: **James VanDerslice, Ph.D.**

Goal: To address environmental equity concerns associated with Superfund activities by developing methods for 1) explicitly incorporating racial, ethnic and economic characteristics of potentially-exposed populations into the risk assessment process, and 2) improving risk communication by developing a better understanding of how environmental risk is perceived and how information about environmental risks is best transmitted.

Rationale: Due to a widespread concern about existing waste disposal practices along the US-Mexico border, risk assessment and risk communication will be key EPA activities in the border region. A better understanding of the populations potentially affected by hazardous waste disposal sites is needed in order to evaluate the socio-economic characteristics of those at highest risk, and to implement risk management strategies which are accepted by local communities.

Approach: A method will be developed to link racial, ethnic and economic data to specific target populations on the basis of proximity to a potential site of a chemical release. Focus groups and a survey will be used to collect information on how environmental risks are perceived, where people get information about environmental problems, and what sources of information are perceived as credible.

Status: The project is complete. Methods have been developed to incorporate socio-economic data from the US Census into a GIS on the basis of block groups, and to retrieve this data based on various geographic criteria. These criteria include a) a circle around a point (which simulates exposure related to the distance to a site such as a leaking storage tank), b) a specified set of census blocks, blockgroups or tracts, or c) any area of potential exposure delineated by an irregular shape defined by the user as a polygon or set of polygons drawn on a map and entered into the GIS using a digitizer. Several problems have become apparent using this approach. First, a relatively high-degree of training is required to use Arc-Info or even Arc View, limiting the application of these techniques; local or regional health or environmental agencies do not appear to have the manpower or computer resources to implement such a system. Second, a PC-based GIS system lacks that

processing power and storage capabilities to easily develop new coverages on a county-wide basis. A regional GIS database would present even greater problems. Thus either the developed data bases must be provided to the user of a PC-based system, or the user must have a workstation. finally, in most areas along the U.S.-Mexico border, Hispanics account for the largest proportion of the population. As such, there are serious issues regarding the selection of comparison populations for assessing environmental justice.

The study to examine risk perceptions in three El Paso communities was quite successful. A total of 7 focus groups were conducted. Based on these results, a 125-item instrument was developed and administered to approximately 50 households in each of three El Paso communities: the lower valley, the east side, and the west side. The questionnaire elicited information regarding what environmental problems ere perceived to pose the greatest risk to the respondent's family and to El Paso as a whole, where the respondent got information about environmental lrisks and how credible these sources were perceived to be, and the respondents attitudes regarding their ability to control environmental risks, the government's ability to control environmental risks, and the importance of environmental risks vis-à-vis other problems they faced. A total of 147 questionnaires were completed. The information was entered into a database and analyzed. The results provided some important insights into the differences in risk perception and in the understanding of environmental problems. Perceptions of risk the knowledge about environmental risks was significantly different between the three communities. Television was the most important source of information. In contrast only a very small proportion of the respondents had even heard of the USEPA. Most government agencies were not seen as credible sources of information. While most respondents felt that something could be done to reduce environmental risks, a majority had no idea about specific actions that they could take. The results of the survey and recommendations for actions to improve risk communication, as well as ideas for further research are presented in the final report.

A day-long workshop was held for individuals involved in environmental activities and outreach efforts from the El Paso City-County Health and Environmental District, UTEP and other local environmental agencies. Despite personal invitations, only half of the targeted individuals were present. At this meeting, the results of the survey were presented, a risk communication seminar was presented, and specific strategies for improving risk communication were discussed.

Potential Users / USEPA and TNRCC risk assessors; state and

Technology Transfer: county health officials working with border communities on environmental health problems; UTEP outreach workers addressing environmental issues.

Other Personnel: Theresa Byrd, Ph.D. Co-PI, Susan Peterson, MPH, MD Anderson Cancer Center, University of Texas Health Science Center.

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Project Title: **Biodegradation of Chlorinated Alkenes and Chlorinated Benzenes by Aerobic Microbial Metabolism**

Principal Investigator: **M. Neal Guentzel, Ph.D.**

Goal: The overall goals of this multiple-year project are: (1) to determine if bioremediation of chlorinated alkenes and benzenes is a viable option for treatment of these and other organic contaminants at a Superfund site; (2) to develop a predictive model for field application of bioremediation; and (3) to conduct field demonstration studies.

Rationale: Contamination of the environment by toxic organics through a variety of avenues, including accidental discharges of petroleum hydrocarbons, past and current negligence, and industrial production and release of xenobiotics has created a number of localized environmental crises of enormous proportions. Chlorinated alkenes and benzenes are among the hazardous chemicals most frequently found at priority contaminated sites. Conventional remediation options include incineration, landfilling, chemical treatment, and *in situ* fixation, all of which are costly, pose regulatory problems, and have an increasingly bad public image. In contrast, bioremediation is gaining widespread public support as an environmentally friendly approach to site cleanup and can provide relatively rapid remediation at a lower cost and with no lingering liability. However, many aspects of environmental bioremediation remain empirical and ad hoc; the process lacks the solid scientific experimental base needed to increase its predictability and diversify its applicability. Our proposed multi-year research will address these problems through laboratory characterization of biodegradation of chlorinated hydrocarbons, computer-based predictive modeling of the bioremediation process, and *in situ* field demonstration of the bioremediation model and processing technology at a Superfund site. The proposed work is highly relevant to the Superfund Environmental Research Program as it is directed toward characterizing and enhancing the microbial degradation of compounds found at many abandoned waste sites. Results of this research, including determination of optimal remediation parameters and development of a predictive bioremediation model, should be applicable to many Superfund sites nationwide.

Approach: Existing computer models used to describe bioremediation have not adequately addressed the role of microorganisms in contaminant degradation. This project's unique focus is to establish a microbial foundation for the

development of a predictive bioremediation model, to refine this model using laboratory simulations and finally to evaluate the performance of the model at an existing Superfund site. A series of research tasks will be undertaken to accomplish these specific aims. Initially, indigenous microorganisms will be isolated from a Superfund site and screened for their ability to metabolize selected chlorinated alkenes and benzenes. Selected isolates and organisms from a "library of degraders" in the UTSA Bioremediation Laboratory with demonstrated ability to metabolize chlorinated hydrocarbons will be used to construct microbial consortia for use in subsequent studies.

Physical models will be used to conduct laboratory testing of remediation of chlorinated hydrocarbons, varying essential parameters needed for development of a preliminary computer model. Initial reactor studies will employ liquid-sand slurries as "flask" models. Subsequently, models simulating surface and subsurface soil zones will be constructed and used to continue the development and refinement of a comprehensive computer-based bioremediation model designed to yield the various *in situ* process parameters. Finally, in collaboration with end users such as the TNRCC and private remediation contractors, the validity of this model will be field-tested at a priority site such as the Pioneer Oil and Refining Company. Field data will be used in further refinement of the predictive model.

Status:

Phase 1: Identification of Superfund-Related Sites and Isolation and Characterization of Indigenous Microorganisms [June 1, 1995 - December 31, 1995]

Three technical tasks were undertaken on an accelerated schedule to isolate and screen indigenous microorganisms, determine rates and products of degradation, and develop appropriate alliances with regulatory agencies and site managers that will permit field demonstration testing of the *in situ* bioremediation process.

Task 1.1. To isolate and screen indigenous microorganisms from Superfund sites to select organisms capable of metabolizing selected chlorinated alkenes and benzenes

Phase 1 research utilized the Pioneer Oil and Refining Company site located near Somerset, Texas, in southern Bexar County. The management and pending cleanup of this hydrocarbon contaminated site is the responsibility of the Texas Natural Resources Conservation Commission (TNRCC). A site visit by UTSA personnel was conducted by Mr. Dean Perkins, the TNRCC project manager, on June 1, 1995. Mr. Luke Parchman, Somerset City Administrator, was also present for the tour. Drs. Guentzel and Moore

collected a total of ten samples from various locations including samples from waste pits and brick tanks on the site. These samples were transferred to the UTSA Bioremediation Laboratory for extensive microbial analyses.

Samples were plated as 10% aqueous slurries directly onto nutrient agar as well as selective agars containing either oil or phenanthrene + toluene. Nontoxic biosurfactants were used to treat those samples having a high content of weathered asphaltic material as a means of solubilizing these samples and releasing any associated microbes. Individual colonies, representing diverse morphologies, were isolated after 1 - 4 weeks. In addition, enrichment cultures were prepared by inoculating samples into minimal broth containing phenanthrene or trichloroethylene (TCE) + trichlorobenzene (TCB) as the sole source of metabolizable carbon. Enrichment cultures were maintained in a shaking incubator at ambient temperature over a period of 4 - 6 weeks. Aliquots from each culture were plated onto agar plates at weekly intervals and colonies were isolated in pure culture.

Using these isolation techniques, a total of 350 bacterial isolates were recovered from nine of the original ten samples. These isolates were subsequently screened for their ability to utilize individual hydrocarbons or more complex hydrocarbon mixtures as a carbon source. A total of 70 bacteria demonstrated some growth on at least one of the hydrocarbons tested. Fifty-six isolates were observed to metabolize two or more of the hydrocarbons tested; while 14 isolates gave positive results on only a single hydrocarbon. Among these isolates, 20 bacteria metabolized chlorinated hydrocarbons including trichloroethane (TCA), TCE, TCB, and/or 1,2-dichlorobenzene (1, 2D).

Task 1.2. To establish rates and products of degradation for indigenous degraders and microbes selected from the UTSA "Bioremediation Library of Hydrocarbon Degraders" with known activity against target compounds

Ten individual bacteria were selected from both the UTSA Bioremediation Library and isolates obtained at the Pioneer Oil and Refining Company site on the basis of preliminary screen data (above) for further hydrocarbon degradation studies. Individual isolates were transferred from a recently inoculated slant into 25 mL volumes of basal minimal salt solutions (BMSS) containing either TCE, TCE + Toluene, and TCE + Toluene + 1, 2D. Inoculated cultures were maintained in an incubated shaker for one month. The turbidity in each flask was then analyzed spectrophotometrically and an aliquot of

sample was removed for reisolation of bacteria. The remaining volumes were stored at 4C for subsequent GC/MS analysis.

Results of GC/MS analysis of each volume will be compared against uninoculated sterile controls. Using this approach, the degradative products of each hydrocarbon sample can be identified. On the basis of this preliminary hydrocarbon degradation testing, the metabolic capacity of individual isolates to degrade selected chlorinated hydrocarbons is being verified. Isolates with confirmed degradation capabilities will be retested to establish degradation rates and to confirm degradation products.

Task 1.3. To develop an alliance between State, Federal, and Private interests to facilitate field testing of bioremediation

Senior investigators at UTSA Bioremediation Laboratory have maintained contacts with the TNRCC Project Manager. Recently, TNRCC awarded a second contract to Woodward-Clyde Consultants (offices in San Antonio, Texas) to complete additional site characterization at the Pioneer Oil and Refining Company site . It is anticipated that 6 to 8 additional monitoring wells will be installed to depths of 20 to 70 feet with drilling to begin in February/March 1996. Prior to this time, Woodward-Clyde will be completing preliminary subsurface sampling to obtain material at various locations on site to determine the nature and relative concentrations of contaminants. The TNRCC project manager is facilitating interactions between UTSA Bioremediation Laboratory and Woodward-Clyde to obtain materials necessary for ongoing and proposed research work related to this Superfund project; specifically for remediation of chlorinated hydrocarbons.

Potential Users / Technology Transfer: Texas Natural Resources Conservation Commission (TNRCC), Environmental Protection Agency (EPA), Environmental Consulting Firms using bioremediation

Other Personnel: Dr. Barbara E. Moore, Co-Principal Investigator

PERSONNEL

Key Personnel

Name	Position	Department	University
Bath, C. Richard, Ph.D.	PI	Political Science	UTEP
Clingermayer, James, Ph.D.	PI	Political Science	UTEP
Currey, Bob	Asst Dir	CERM	UTEP
Dowdy, Jack A., Ph.D.	Co-PI	Mech & Ind Engr	UTEP
Fredrickson, Patricia, Ph.D.	Co-PI	Political Science	UTEP
Gardea-Torresdey, Jorge, Ph.D.	PI	Chemistry	UTEP
Goodell, Philip, Ph.D.	PI	Geology	UTEP
Groat, Charles G. (Chip), Ph.D.	Director	CERM	UTEP
Guentzel, M. Neal, Ph.D.	PI	Div of Life Sciences	UTSA
Herndon, William, Ph.D.	PI	Chemistry	UTEP
Leonard, C. Wesley	Assoc Dir	CERM	UTEP
Miller, Kate, Ph.D.	PI	Geological Sciences	UTEP
Moore, Barbara, Ph.D.	Co-PI	Div of Life Sciences	UTEP
Neighbor, Howard, Ph.D.	Co-PI	Political Science	UTEP
Ohlmacher, Gregory, Ph.D.	PI	Geological Sciences	UTEP
Owen, Thomas E., Ph.D.	Director	Inst for Research in Sciences and Engineering	UTSA
Peterson, John, Ph.D.	PI	Sociology & Anthropology	UTEP
Picornell, Miguel, Ph.D.	Co-PI	Civil Engineering	UTEP
Quintana, Rolando, Ph.D.	PI	Mech & Ind Engr	UTEP
Riter, Stephen, Ph.D.	VP Acad Affairs		UTEP
Robbins, Mary Clare, Ph.D.	PI	Mech & Ind Engr	UTEP
Sanford, Julie, Ph.D.	VP Research & Grad Studies		
Tarquin, Anthony, Ph.D.	Co-PI	Civil Engr	UTEP

Name	Position	Department	University
VanDerslice, James, Ph.D.	PI	School of Public Health	UT - Hlth Sci Ctr, Houston (El Paso program)
Vila, Pablo, Ph.D.	Co-PI	Sociology & Anthropology	UTEP
Walsh, Elizabeth, Ph.D.	PI	Biology	UTEP
Walton, John, Ph.D.	PI	Civil Engr	UTEP
Webb, Robert, Ph.D.	PI	Biology	UTEP
Weaver, William, Ph.D.	PI	Political Science	UTEP

Other Personnel

(Consolidated)

Byrd, Theresa, Dr.P.H.	Univ of Texas Sch of Public Health, MPH Program at UTEP
Henning, John A., Ph.D.	New Mexico State Univ, Dept. Of Agronomy & Horticulture
Jones, Larry, Ph.D.	UTEP, Dept. of Biology
Pillai, Suresh, Ph.D.	Texas A&M Research Station, El Paso
Smith, Robert, Ph.D.	Idaho National Engineering Laboratory

CENTER FUNDING

Funding Sources	Received to date	Expended to date
EPA	$3,000,000	$1,778,661
EPA, other (MAI)	$299,729	$299,729
Other federal (DOE: HBCU/MI; and MUTEC)	$65,220	$65,220
State/local		
University (Matching)	$287,958	$287,958
Private Sector		
Total	**$3,652,907**	**$2,431,568**

Student Support*

Category	Number	Minorities	Amount
Undergrad	29	19	$367,060
Graduate	19	8	$393,216
Post Doc	0	0	0
Totals	**48**	**27**	**$760,276**

**Includes: MAI--$299,729; MUTEC and HBCU/MI--$65,220*

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Bath, C. R., " **The Sunland Park, New Mexico Landfill Facility: A Case Study of the Complexities of Environmental Equity/ Justice** ," Western Social Science Asssociation, Oakland, April 28, 1995.

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Recognition

Masudur Rahman, graduate research assistant, presented and defended his MS thesis on flow through flaws to the faculty of the graduate school to procure his master of science degree.

David Casey, graduate research assistant, attended and lectured at the Hydrology Days Conference at Colorado State University in Ft. Collins, Co.

Floyd Johnson, undergraduate research assistant, placed 2nd in “undergraduate” category at the 1994 National Science and Technology Week - Spring Into Science and Technology, UTEP’s Student Research EXPO.

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II. Project reports and publications: **Flow Through Flaws in Impermeable Barriers**

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"**Flow Through Flaws in Flexible Membrane Liners: A Complete Study of Controlling Factors** ," extracted from the *Proceedings of American Geophysical Union, Fourteenth Annual Hydrology Days, April 5-8, 1994* II-3

III. Project reports and publications: **Environmental Justice, Hispanics, and the Disposal of Wastes in the El Paso Region**

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"**Low Level Radioactive Waste Dumping in West Texas: Another Example of Texas Racism** ?," Dr. Howard D. Neighbor, a paper for delivery at the WSSA/ABS Meeting, Aril 1994. III-4

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IV. Project report: **Role of Carbonation in Long-Term Performance of Cementitious Wasteforms -- Carbonation of Cementitious Wasteforms** IV-1

V. Project publications: **Bioreduction of Chromium in Contaminated Soils and Potential Application to the Bioremediation of Cr(VI) Contaminated Sites**

"Attempts to Achieve Bioremdiation of Hexavalent Chromium in Batch Cultures Using Contaminated Soil from a Superfund Site," poster presented at the American Society of Agronomy Meeting, St. Louis, Missouri, November, 1995 . V-1

VI. Project Publications: **Removal and Selective Recovery of Heavy Metal Ions from Superfund Sites Using Biological Materials**

"**Uptake of Copper Ions from Solution by Different Populations of *Medicago Sativa* (Alfalfa),**" *Solvent Extraction and Ion Exchange* VI-1

"**Removal of Copper Ions from Solution by Silica-Immobilized *Medicago Sativa* (Alfalfa),**" published in the *Proceedings of the 10th Annual Conference on Hazardous Waste Research* VI-2

"Ability of *Medicago Sativa* (Alfalfa) to Remove Nickel Ions from Aqueous Solution ," published in the *Proceedings of the 10th Annual Conference on Hazardous Waste Research* VI-3

"**Copper Binding by Inactivated Cells of *Mucor Rouxii*,"** published in the *Proceedings of the 10th Annual Conference on Hazardous Waste Research* VI-4

"**Ability of Silica-Immobilized *Medicago Sativa* (Alfalfa) to Remove Copper Ions form Solution ,"** manuscript accepted for publication in the *Journal of Hazardous Materials*, October, 1995. . . . . VI-5

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"**Investigation on the Binding of Metal Ions to Inactivated Cells of *Medicago Sativa* (Alfalfa) and Silica-Immobilized Alfalfa ,"** Master's Thesis prepared by Kirk Tiemann, December 1995 . . . . . VI-7

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